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Computer-Aided Design AND APPLICATIONS

Deep Learning-Driven Interior Design CAD System: Achieving Efficient Collaboration and Innovation

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Abstract. With the continuous improvement of modern living standards, people's expectations and requirements for interior design are also increasing, which brings unprecedented opportunities and significant challenges to interior decoration design enterprises. As an important tool in the field of intelligent design, CAD has gradually penetrated into various aspects of interior design as the core link of interior design, the complexity and precision of interior space layout design pose higher requirements for design quality and efficiency. However, traditional CAD systems often face problems such as low efficiency, poor collaboration, and limited innovation ability in indoor space layout design. This article proposes a deep learning (DL) driven interior design CAD system to address these issues. This system utilizes the DL algorithm for intelligent analysis and optimization of indoor space layout, aiming to achieve efficient collaboration and innovation in design. The experimental results indicate that the system can not only effectively improve the precision and efficiency of design but also provide more innovative space for designers.

Keywords: Deep Learning; Interior Design; CAD System; Efficient Collaboration and Innovation
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1 INTRODUCTION

Addressing the shortcomings of existing CAD drawing analysis methods in terms of robustness, efficiency, and insufficient detail in extracting parameters. Ahmad et al. [1] designed a merging adjacency and capping parallel wall line algorithm to preprocess drawings, improving the fault tolerance of the search loop algorithm on drawings. Then, a new drawing parsing strategy was proposed around the creation and use of custom data structures - semantic polygons. Based on this, several algorithms have been designed to improve the extraction efficiency, accuracy, and richness of conventional building components such as doors and windows. It has achieved the extraction of detailed modelling parameters for complex building components - stairs and elevators, enabling them to support parametric modelling during the 3D reconstruction phase. Finally, the improved search ring algorithm is used to extract the boundaries of functional areas, and a method for identifying functional area types beyond semantic annotation is extended to obtain the spatial pattern information of the entire floor. A non-edge-oriented vector indoor road network generation algorithm is proposed to address the shortcomings of existing vector indoor road network generation algorithms that have edge tendencies (i.e., paths close to or located on wall lines). The road network data generated by this algorithm has no edge tendency compared to traditional visual graph methods, and due to the clear and simple road network, the storage space occupation is also lower. In addition, to make the results more universal, it also designed a method to convert indoor road network results into a universal road network storage format - an undirected weighted graph [2].

In recent years, with continuous breakthroughs in technologies such as computers, virtual simulation, big data, cloud storage, and the Internet of Things, the construction of smart cities at home and abroad has shown explosive growth. As the core organizational unit of a city, the traditional way of representing buildings in two-dimensional planes can no longer meet people's needs for integrated management and analysis of indoor and outdoor buildings. Many scholars have studied the standards for building 3D models in the fields of BIM and GIS and proposed an integrated representation method for indoor and outdoor buildings based on BIM+GIS. Denerel and Anil [3] studied the building spatial information model of BIM+GIS, starting from the open standard IFC (Industry Foundation Classes) in the BIM industry and the open standard City GML in the geographic information industry. It explores the construction of geometric, semantic, topological, and attribute information for building spatial information models starting from the planar CAD data of buildings. Finally, through an example of an intelligent management system in a park, the application concept of the building spatial information model is verified. Regarding the three-dimensional model representation of buildings, paragraph [4] starts from the international standard exchange format IFC in the BIM industry and the international exchange standard City GML in the geographic information industry and compares the four levels of geometry, semantics, topology, and attributes of buildings. Design architectural spatial information models from a conceptual and logical perspective. Introduce detailed architectural semantics and attribute information from BIM into the design of architectural spatial information models, describe the spatial composition of buildings, and introduce spatial topological connectivity from geographic information into architectural spatial information models to compensate for the lack of spatial topological relationships in buildings. Realize a comprehensive description of the space and information of the building. For the architectural spatial information model designed, Fu et al. [5] started with traditional planar CAD data, first studied the simplification algorithm of CAD data, and then constructed a family model for the special building components of the research object. Finally, implement the construction of indoor and outdoor models of buildings on Revit. Based on the characteristics of the research object, abstract the space of the model. Implement spatial inclusion relationships in buildings through coding. And implement the construction of spatial connectivity relationships on ArcGIS.

At the same time, the emergence of CAD software has also brought tremendous changes to the interior design industry. Gao et al. [6] explored how 3D modelling behaviour patterns affect the creativity of sustainable architectural design through process mining techniques. Process mining is a data analysis-based method that collects, analyzes, and visualizes a large amount of actual operational data, revealing the behavioural patterns and patterns hidden behind the data. In addition, the collaboration mode in the 3D modelling process also has a significant impact on the creativity of designers. Through collaboration and data sharing among multiple people, designers can learn from each other, draw inspiration from each other, and jointly promote innovation in sustainable architectural design. These software not only organically combine 2D drawing with 3D drawing, allowing for the joint display of flat and three-dimensional views, but also their drawing advantages far exceed traditional manual drawing methods. Based on the three-dimensional model of architectural spatial information designed, the application scenarios of architectural models were analyzed and designed from the perspective of BIM+GIS. Hu et al. [7] developed an intelligent park management system based on the constructed 3D model using the Unity3D engine. Through six major functions including virtual roaming, environmental simulation, asset management, measurement analysis, construction simulation, and emergency response plans. Realize indoor and outdoor integrated roaming and browsing of building models. Space measurement of indoor and outdoor objects, query of building components, call of monitoring information, simulation of construction progress, display of emergency plans, etc. Verify the design of the model from the application level. Starting from the international standard exchange format IFC in the BIM industry and the international exchange standard City GML in the geographic information industry, this study compares architecture from four levels: geometry, semantics, topology, and attributes. Design a building spatial information model from a conceptual and logical perspective. Introduce detailed architectural semantics and attribute information from BIM into the design of the building spatial information model. Afterward, describe the spatial composition of the building and introduce the spatial topological connectivity in geographic information into the building spatial information model. It compensates for the lack of spatial topological relationships in buildings and achieves a comprehensive description of the building's space and information.

Among the commonly used urban 3D modelling methods, manual modelling has a good effect, but it is low in efficiency and high in cost. Laser and oblique images can quickly and semi-automatically construct large urban building models, but the cost is high and indoor information is lacking. Jian and Hao [8] started from traditional planar CAD data for designing architectural spatial information models. Firstly, research the simplification algorithm of the data, and secondly, construct a family model for the special building components of the research object. Finally, implement the construction of indoor and outdoor models of buildings on Reit. Based on the characteristics of the research object, abstract the space of the model and implement the spatial inclusion relationship of the building through coding. The application part of building models was implemented on ArcGIS to construct spatial connectivity relationships. Design application scenarios for building spatial information 3D models from the perspective of BIM+. Using the Unity3D engine, a park intelligent management system was developed based on the constructed 3D model. Through virtual roaming, environmental simulation and other functions, the integrated indoor and outdoor browsing and display of building models can be achieved, and the design of the model can be verified from the application level. It starts from architectural design and construction CAD files, simplifies the modelling process with some methods and algorithms, and quickly constructs the integrated geometric, semantic, and topological model data of the building. Apply it to the full lifecycle management of buildings.

By applying DL technology, designers can more accurately grasp user needs and preferences, and generate design solutions that meet personalized needs. Meanwhile, DL technology can also help designers incorporate more innovative elements into their designs, enhancing their uniqueness and competitiveness. Based on the above background, this article proposes a DL-driven interior design CAD system. This system utilizes the DL algorithm for intelligent analysis and optimization of indoor space layout, aiming to achieve efficient collaboration and innovation in design. Through this system, designers can more efficiently complete design tasks, improve design quality, and bring users a more comfortable and beautiful living environment.

2 RELATED WORK

In landscape design, the application of CAD drawing technology enables designers to simulate and present landscape spaces more accurately. Through precise measurement and modeling, digitize the three-dimensional form, material, light, and shadow elements of landscape space. Enable designers to have a more intuitive understanding of the effectiveness of design schemes and make timely adjustments and optimizations. In interior design, CAD drawing technology also plays an indispensable role. There are many factors to consider in interior design, including spatial layout, furniture placement, material selection, colour matching, etc. CAD drawing technology can help designers quickly generate floor plans, elevations, and 3D renderings of indoor spaces, enabling them to have a more comprehensive understanding of the overall effect of the design scheme [9]. The design of steel structures in high-rise buildings is becoming increasingly complex, and the requirements for 3D CAD preprocessing systems are also increasing. Traditional CAD preprocessing systems often fail to meet the special requirements of high-rise building steel structure design. Lu

[10] analyzed the optimization of an object-oriented 3D CAD preprocessing system for high-rise building steel structures. Applying object-oriented thinking to the 3D CAD preprocessing system of high-rise building steel structures can not only improve the modularity of the system but also better adapt to the constantly changing requirements in the design process. In the optimization process, the first step is to conduct a thorough analysis of the characteristics of high-rise building steel structures and clarify the key elements and constraints in their design process. These elements include the geometric shape of steel components, connection methods, stress characteristics, etc., while constraint conditions involve building codes, safety standards, construction conditions, etc. By sorting out these elements and conditions, clear directions can be provided for system optimization.

Using the immersive virtual reality technology of the interior design CAD system, Safikhani et al. [11] presented the design scheme in a highly realistic form to clients and construction teams. Enable them to have a more intuitive understanding of design intent and requirements, thereby improving communication efficiency and reducing misunderstandings and rework. The construction team can obtain detailed building information, including component dimensions, material types, installation locations, etc., through the 3D building model generated by the interior design CAD system. These pieces of information can provide precise guidance during the construction process, reduce construction errors, and improve construction accuracy and efficiency. Meanwhile, immersive virtual reality technology can also simulate the construction process, helping construction teams better anticipate and respond to potential problems, further ensuring the smooth progress of construction. As a concept of spatial design, the depth hint of the painting has had a profound impact on the depth of the interior space of the Lin Family Garden. Tai [12] creates and enhances the depth of space through artistic techniques in painting. This concept has been fully reflected in the interior design of the Lin Family Garden. The designer cleverly utilizes elements such as colour, light and shadow, and lines to create a profound and layered indoor space. Wu et al. [13] studied, improved and expanded existing methods for extracting architectural information from CAD drawings. To contribute to the improvement of the CAD drawing analysis method system. In terms of identifying building components, it proposes the idea of combining floor spatial patterns to identify the internal building components of a room. Breaking the traditional fixed pattern of relying solely on geometric and semantic features to identify building components. This makes it possible to extract detailed parameters of complex building components such as stairs and elevators based on floor plans, in order to extract sufficient parameters for the most realistic restoration of indoor 3D scenes. Expanding the method of identifying functional area types beyond semantic guidance in floor spatial pattern recognition can significantly improve the recognition ability of room types.

Many scholars at home and abroad are conducting research on the standards and data production of building 3D models. However, due to the complexity of three-dimensional space and the different application directions, there is not a good three-dimensional format that can meet all application needs. There are still significant issues with the production of 3D data and the integration of existing data. Yang [14] compared several existing data production methods. Whether constructing 3D models from traditional GIS and CAD data or using the latest 3D laser scanning method for urban 3D modelling, the modelling efficiency, cost, and effect are not ideal. Especially lacking in the expression of indoor and outdoor integration, the expression of the topological relationships within the building's interior space is even more inadequate. The current situation in urban indoor modeling is that on the one hand, our existing 3D building modeling methods lack indoor model information. On the other hand, we have a lot of 2D CAD data for building interiors that cannot be well utilized to define integrated 3D models for indoor and outdoor environments. Building a three-dimensional model that meets the needs of smart city applications and full lifecycle management of buildings from existing CAD data is currently the main problem and the difficulty of this study. The technical roadmap of Zhang et al. [15] mainly involves analyzing the application methods and existing problems of existing building 3D models and obtaining the requirements for building 3D models that integrate BIM and GIS. Then, comparative analysis and research will be conducted on the standard exchange format FC in BIM and the standard exchange format City GML in GIS, exploring the integration of BIM and GIS into a building spatial information model from a conceptual and logical perspective. After clarifying the requirements for building spatial models, starting from the CAD design and construction data of building plans, the geometric construction of the 3D modelling model is simplified through the simplification algorithm processing of CAD data and the construction of family models of building model components. At the same time, the floor space of the building is divided to construct the topological relationship of the building spatial information model. Finally, design the application of the constructed architectural spatial information model throughout the entire lifecycle of the building. Based on the Unity3D engine, design an intelligent management system for Zhengzhou Weikom Park to verify the application of building spatial information models in the field of BIM+GIS. Deep learning can simulate the lighting effects of indoor spaces under different lighting conditions, helping designers predict and adjust lighting schemes to achieve a more natural and comfortable lighting environment.

The research in the field of interior design and optimization is constantly deepening and developing, from early layout theory to modern DL algorithms. The continuous progress of technological means provides more possibilities and innovative space for interior design. In the future, with the further development of technology, we can expect more breakthroughs and innovations in the field of interior design.

3 THE APPLICATION OF CAD AND DL IN INTERIOR DESIGN

3.1 CAD

The application of CAD software is crucial in interior design work, as it almost runs through the entire design process and plays a crucial role. CAD is software that utilizes computers and their graphic devices to assist designers in their design work. In the field of interior design, the application of CAD software not only improves the efficiency of design but also ensures the precision of design, enabling interior design schemes to be more accurately and efficiently converted into construction drawings and providing strong support for subsequent construction work. Firstly, in the initial stage of design, CAD software is mainly used to draw indoor floor plans. Designers can use CAD software to combine customer needs, spatial characteristics, and design concepts to draw preliminary layout plans. During this process, the precise drawing function of CAD software enables designers to express their ideas accurately while also facilitating customers' understanding of the design scheme more intuitively.

Secondly, as the design progresses, CAD software will also be used to draw construction drawings for plans, elevations, and sections (as shown in Figure 1).

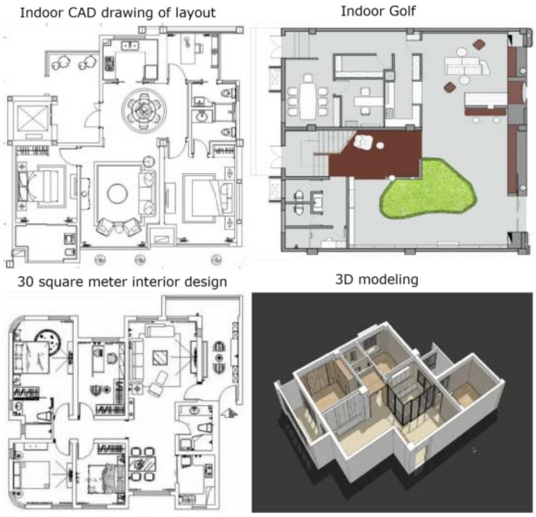

Figure 1: Application of CAD in interior design.

3.2 DL

Deep learning mainly includes two aspects: first, research on artificial neural networks in the field of machine learning. The second is to study higher-order thinking patterns in the field of science. The deep learning in this study belongs to the field of learning science. In the past decade, the main research on deep learning in China has shown a significant increase in quantity, specifically involving three aspects: "research on teaching and learning", "cultivation of subject literacy", and "application of educational technology". At the same time, there are also phenomena such as insufficient momentum, prominent differences, and a focus on intelligence over morality in research. The research on deep learning in the field of education urgently needs to increase innovation and find new breakthroughs. It analyzes the research on deep learning in teaching and learning, and we can summarize that deep learning in teaching and learning research involves teaching methods, teaching strategies, teaching processes, teaching evaluations, and other aspects. The inspiration for this study is that deep learning occurs throughout the entire teaching process and is the result of the transformation of multiple elements. Based on the logic of transforming various elements in teaching and learning, a dynamic adaptive learning mode is achieved by dynamically adjusting the interaction between these elements. The extraction of spatial and attribute (type) data of functional areas within floors is an important foundation for generating geometric, attribute, topological, and path data of 2D and 3D indoor maps in this article. Therefore, this article designs a semantic interior structure. One is to effectively organize the geometric and attribute data of the functional area. Based on this, the topological relationship between functional areas and between functional areas and doors and windows can be derived. The second is to combine it with building component symbols to extract parameters that are sufficient to restore the three-dimensional landscape of complex building components such as stairs. The third is to derive indoor path data based on this.

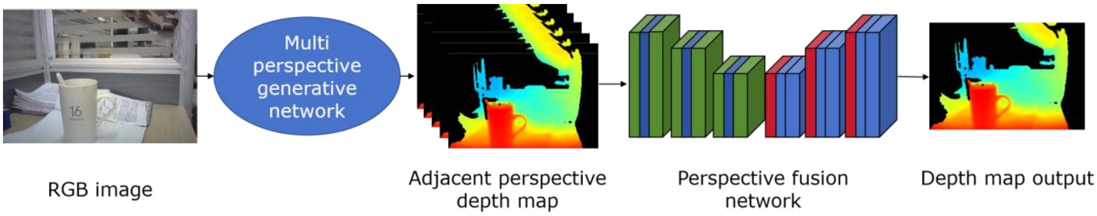

Figure 2: Multi-perspective fusion network structure.

4 DL DRIVEN INTERIOR DESIGN CAD SYSTEM

4.1 System Building

Based on the above analysis, this article proposes the following methods for generating spatial, attribute, topology, and path data for 2D and 3D indoor maps. The process of this method can be divided into the following stages, among which the first three stages belong to the drawing analysis stage, which is the foundation and key to generating indoor map data.

(1) Pre-processing stage of drawings. This is the foundation for automatically generating indoor map data, which includes two aspects. One is to identify the layers on which various building components such as doors and windows and annotations are located and establish layer mapping. The second is to merge parallel line segments adjacent to and covered in the wall line layer.

(2) Extraction stage of framework building components. This stage includes two aspects: one is to use the closed-loop algorithm to extract the contour of the balcony railing and obtain a polygon representing its horizontal cross-section. The second is to use the symbols of balconies doors and windows as guidance to cut and splice adjacent wall lines. On the one hand, it restores the integrity of the wall and prepares for extracting the complete boundaries of the functional area. On the other hand, detailed parameters of doors and windows are extracted during this process.

(3) Stage of extracting floor spatial pattern. The ultimate goal of this stage is to generate a semantic polygon set data design.

In the context of the urgent need for integrated indoor and outdoor building models, this article studies the concept of building spatial information model in DL and constructs a building spatial information model from geometric, semantic, topological, and attribute aspects based on building plane CAD data. Finally, an application scenario for building a spatial information model was designed, and an intelligent park management system was developed based on the Unity3D engine to verify the application design of the model. And analyze the current status of standards and data production methods for building 3D models. Based on existing research, propose a research approach for modelling processes based on CAD data. Finally, the main research content, research route, and organizational structure of the paper were introduced. Based on the application requirements of the construction industry, this paper studies the three-dimensional models of buildings and summarizes two key changes in the process of building informatization, from manual drawing to CAD drawing and layout work, and then to BIM full lifecycle management of buildings. Studied the application of BIM technology in the entire life cycle of buildings, including the main tasks of project planning, project design, project construction, and project operation stages, as well as the application direction of BIM in each stage of management. At the same time, raised the problems that appeared in the management of the entire life cycle of buildings, and finally proposed a new research direction of the integration of BIM and GIS.

4.2 Algorithm Selection

The indoor space layout problem can be regarded as a special constraint satisfaction problem, whose uniqueness lies in the need to find the optimal solution among a limited number of possible layout schemes. This is essentially a combinatorial optimization problem that involves finding the optimal solution or solutions from all possible combinations under given constraints. For the convenience of discussion, the indoor space layout problem is represented as a general combinatorial optimization problem:

$$\begin{aligned} \min \quad & f\ x \\ s.t. \quad & g\ x \geq 0 \\ & x \in D \end{aligned} \tag{1}$$

Among them, x are the configuration variable in indoor space layout, $f\ x$ the objective function, $g\ x$ the constraint equation, and D the domain of the configuration variable.

Building a target prediction network for indoor space layout in DL is a complex task. The main objective of this network is to extract useful features from input data and generate voxel meshes of target objects in the scene. In the realm of network architecture, the encoder fulfills a crucial role by compressing input data into concise high-dimensional vector representations. Conversely, the decoder takes on the task of transforming these vectors back into voxel space, ultimately generating the anticipated voxel grid. To assess the accuracy of the network's predictions, the scene target object loss function is determined by comparing the predicted voxels with the actual voxels using the cross-entropy loss metric. Assuming that the predicted scene object is represented by the symbol $\hat{V}_n$ and the true voxels are represented by the symbol V_n, the loss function can be expressed as:

$$L_v = \frac{1}{N}\sum_n V_n \log \hat{V}_n + \ 1 - V_n\ \log\ 1 - \hat{V}_n \tag{2}$$

It is crucial to ensure that all rooms are within the layout definition domain in an effective layout. The rectangular defined areas and room units in the layout, provide us with clear geometric constraints. These internal constraints ensure that the four corners of each rectangle are within the defined area of the layout, thereby achieving reasonable spatial division and effective utilization. The internal constraints are represented as:

$$\begin{cases} 0 \le x_i \le w \\ 0 \le y_i \le d \\ x_i + w_i \le w \\ y_i + d_i \le d \end{cases} \tag{3}$$

Among them, $1 \le i \le N$, N are the specified number of rooms, and w,d the width and depth of the defined area of the layout, respectively.

The perspective generation network mainly utilizes the method of depth map completion to generate depth maps under specific perspectives. This design not only provides necessary adjacent perspective depth information for the perspective fusion network but also lays a solid foundation for predicting depth values. In order to avoid interference from pixels with non-existent depth values on the final prediction results, the multi-view generation network adopts partial convolution operations. The core of this operation is that the convolution kernel only convolves the effective regions in the depth map, ensuring the precision and reliability of information. At the same time, the introduction of a mask matrix further enhances the pertinence and effectiveness of some convolutions, enabling the network to accurately locate the regions that require convolution. The formula is as follows:

$$x' = \begin{cases} W^T \ X \cdot M \ \dfrac{sum \ 1}{sum \ M} + b, & if \ sum \ M \ > 0 \\ 0, & otherwise \end{cases} \tag{4}$$

Among them, W is the weight in the convolutional filter, and b the corresponding bias value. X represents the eigenvalues in the current convolutional layer, and M represents the corresponding binary mask matrix. In the formula, 1 represents the product of each pixel, and 1 represents a size matrix of all 1s that is the same size as the mask matrix. From this formula, it can be seen that the convolution operation is only performed on the part where the mask is 1.

After each partial convolution operation, the mask is updated as follows:

$$m' = \begin{cases} 1, & if \ sum \ M \ > 0 \\ 0, & otherwise \end{cases} \tag{5}$$

When a pixel has a valid depth value, the value at that position in the mask matrix is updated to 1, which can be considered a valid pixel point.

Under the premise of meeting basic constraints, the optimization objective is set to cover the defined area of the layout as much as possible. This means that when planning indoor space layout, reducing unused or covered areas can improve space utilization and overall layout rationality. Therefore, the energy function of the basic algorithm is defined as:

$$E_{\mathrm{cov\,er}} \ L \ = Area \ L \ - \sum_i w_i \times d_i \tag{6}$$

Where $Area \ \cdot$ represents the area of the layout defined area.

In indoor space layout, the depth values at close range are usually more crucial for observers, as they directly affect our intuitive perception of object position and size. Therefore, this article uses a new loss function to differentiate the depth values of different areas. The loss function is as follows:

$$l_{depth} = \frac{1}{n} \sum_{i=1}^{n} F \ e_i \tag{7}$$

$$F \ x \ = \ln \ x + \sigma \tag{8}$$

Among them, $e_i = \left| d_i - g_i \right|$, d_i represents the predicted depth map, g_i represents the true depth map, and σ is set to 0.5.

5 RESULT ANALYSIS AND DISCUSSION

To validate the system's performance outlined in this article, subsequent experiments will be undertaken. Illustrated in Figure 3 is a comparative analysis of loss functions across various system algorithms. Notably, our system's loss function curve exhibits a swifter convergence rate, unequivocally highlighting its efficacy and superiority in addressing interior design tasks discussed here. This rapid convergence ensures swifter attainment of lower loss values, enabling the system to swiftly decipher the underlying patterns and characteristics of the data, thus facilitating the generation of more precise indoor space layouts. Such a capability holds immense importance in enhancing design efficiency and mitigating computational resource expenditure in practical applications.

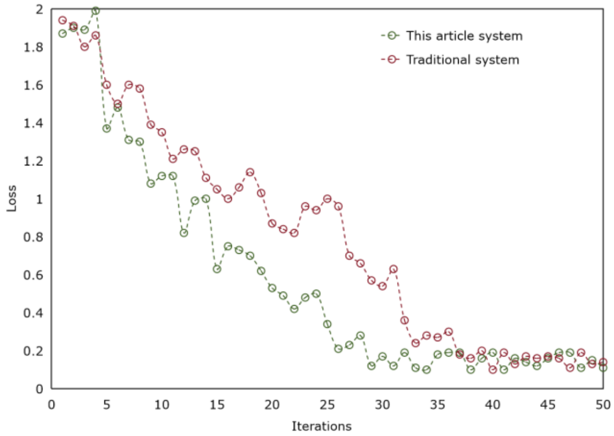

Figure 3: Comparison of loss functions.

Figure 4 shows the comparison of design precision between different systems in indoor design tasks. Design precision is one of the important indicators for measuring the performance of interior design systems. It reflects the degree to which the layout scheme generated by the system matches the actual requirements. From the figure, it can be seen that the design precision of the system in this article is significantly higher than that of traditional systems.

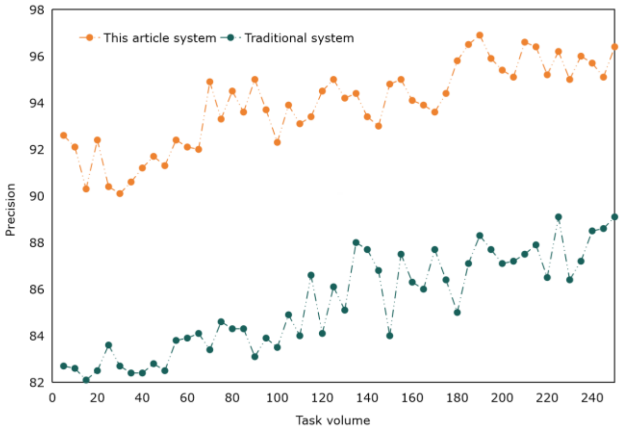

Figure 4: Comparison of design precision.

Figure 5 shows a comparison of the speed at which different systems process design tasks. Processing speed is an important indicator of a design system's performance, which directly affects the designer's work efficiency and user experience. It can be clearly seen from the figure that compared to traditional systems, the system in this article requires significantly shorter time to handle the same design task. This means that designers can obtain design results faster, enabling them to make subsequent adjustments and optimizations earlier. This not only helps to improve the quality of design but also provides designers with more opportunities for iteration and trial and error, further enhancing the innovation and practicality of design.

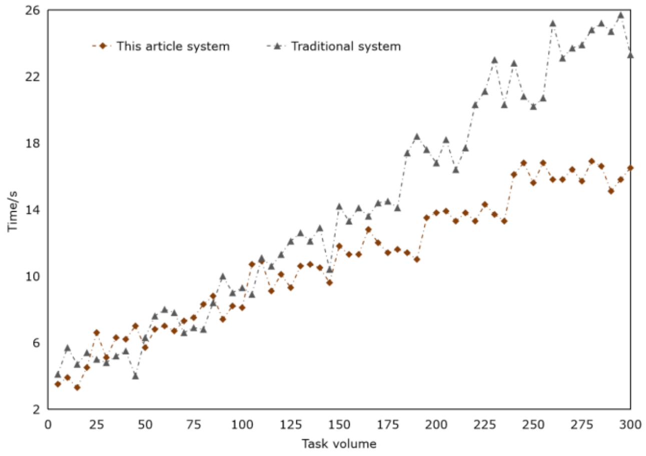

Figure 5: Comparison of processing speed.

Figure 6 shows a comparison of user satisfaction with different system design contents. User satisfaction is an important indicator of the success or failure of a system design, which directly reflects the degree of fit between system design and user expectations. In Figure 6, we can see that the user satisfaction with the system in this article is significantly higher than that of the traditional system. This result fully demonstrates the superiority and attractiveness of the system in interior design content in this article. The system in this article can generate indoor space layouts that better meet user expectations and needs through precise deep prediction and optimized layout algorithms, thereby improving overall user satisfaction. This advantage makes the system in this article more competitive and has a wider range of application prospects in the field of interior design, which can meet the personalized needs of more users and provide a better design experience.

Figure 7 compares the throughput of different systems. Throughput is a key indicator of a system's ability to handle a large number of tasks, especially when facing massive data. The throughput of a system directly determines its efficiency and speed in processing tasks. From Figure 7, we can see that compared to traditional systems, our system exhibits higher throughput in handling massive design tasks. This means that the system in this article can handle a large number of design tasks more quickly, effectively addressing the needs of high concurrency and large-scale data processing.

Table 1 shows the comparison of CPU usage among different systems when processing different task volumes. CPU usage is an important indicator of system performance, which reflects the utilization of computing resources by the system during task execution. From Table 1, we can see that the CPU usage of our system remains relatively low when dealing with different task volumes. This indicates that the system in this article can more efficiently utilize CPU resources and avoid excessive consumption and waste of resources when executing design tasks.

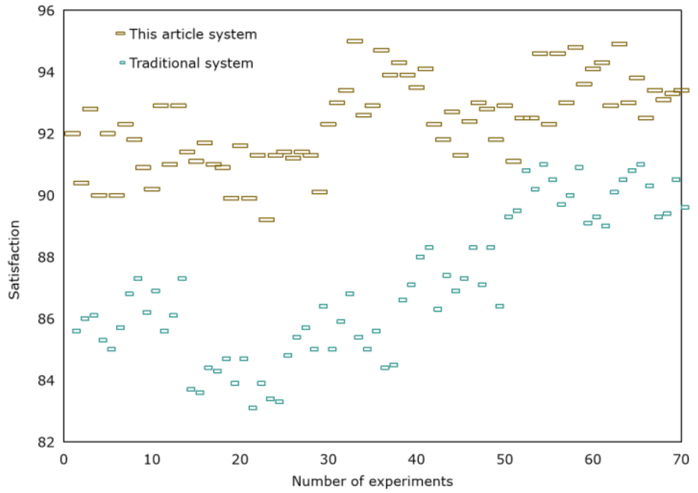

Figure 6: Satisfaction comparison.

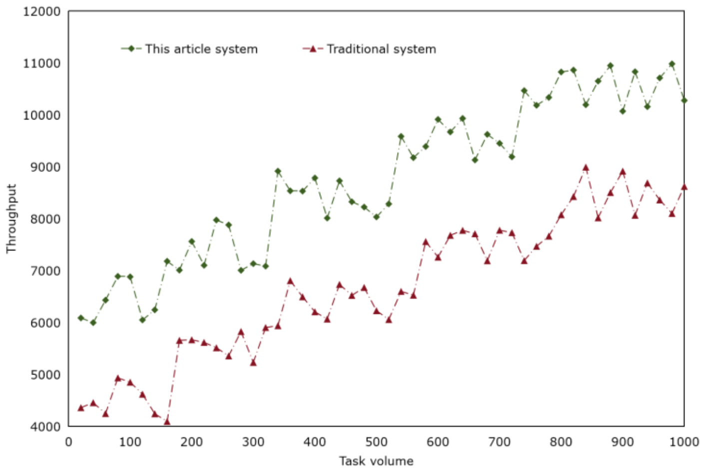

Figure 7: Throughput comparison.

Task volume	*This article system*	*Traditional system*
100	63	84
200	69	89
500	74	93
1000	77	96

Table 1: CPU utilization rate/%.

6 CONCLUSIONS

As CAD software technology continues to evolve and refine, its utilization in interior design has broadened significantly, leading to a notable enhancement in the professionalism and efficiency of design endeavours. These software tools not only enrich the realm of interior design but also empower designers to express deeper meanings and creativity through diverse material selections and streamlined operational methods. This article introduces a DL-driven interior design CAD system that harnesses the robust capabilities of DL to intelligently analyze and refine indoor spatial configurations. By leveraging the DL algorithm, the system can autonomously identify spatial attributes, comprehend user preferences, and produce efficient and rational layout plans accordingly. This approach not only enhances the accuracy and speed of design processes but also allows designers to devote more attention to creativity rather than being bogged down by tedious calculations and adjustments. Experimental outcomes demonstrate the system's superior performance in practical applications, outperforming traditional systems in terms of precision and speed, thereby better satisfying user demands.

Although this article has achieved certain results in the field of interior design CAD systems, there are still some shortcomings. Different indoor space layouts and user needs have complexity and diversity, requiring more precise and flexible algorithms to adapt to various situations. Therefore, future research can further explore new DL models and technologies to improve the precision and robustness of algorithms.

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